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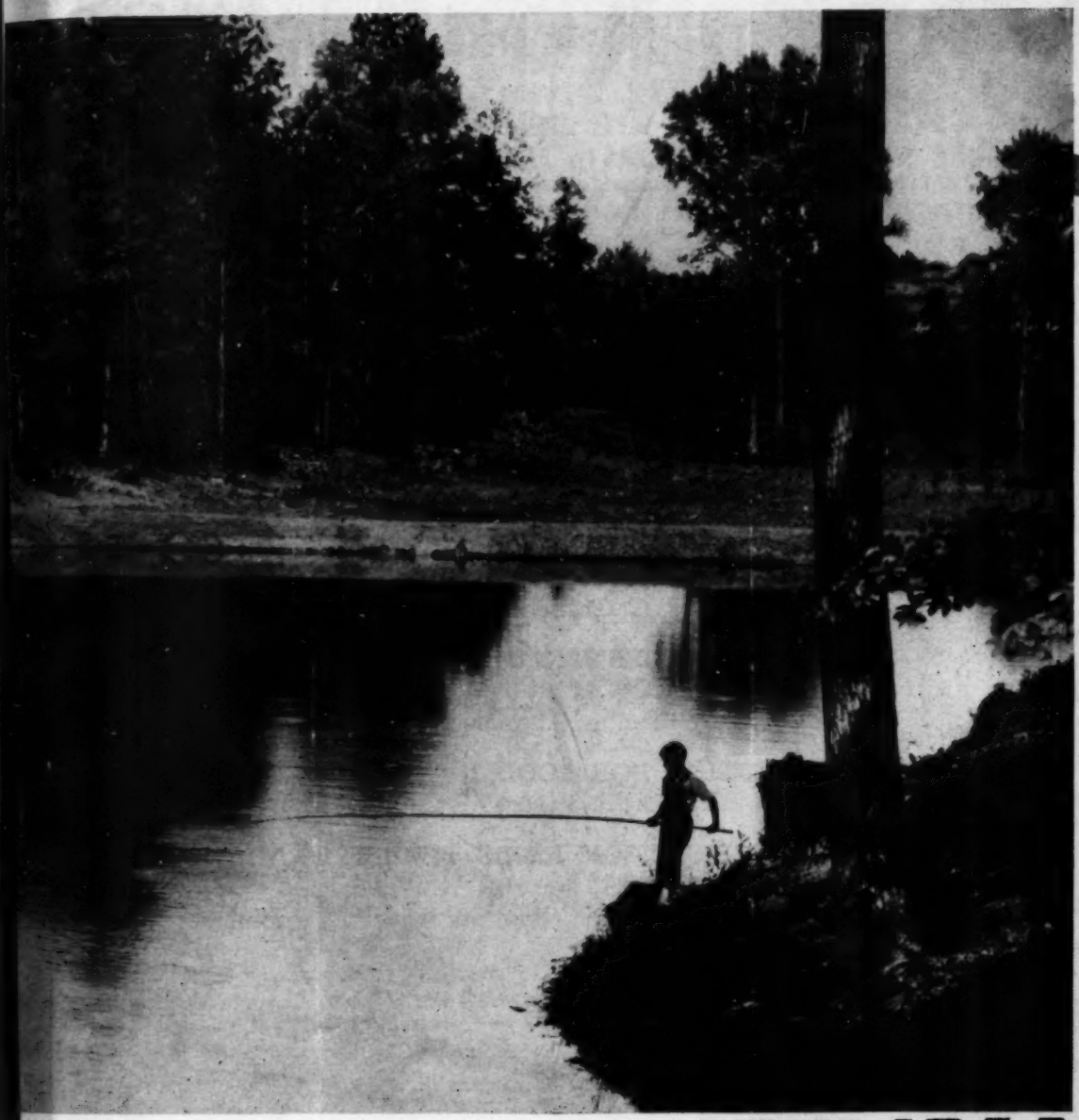

JULY 1944

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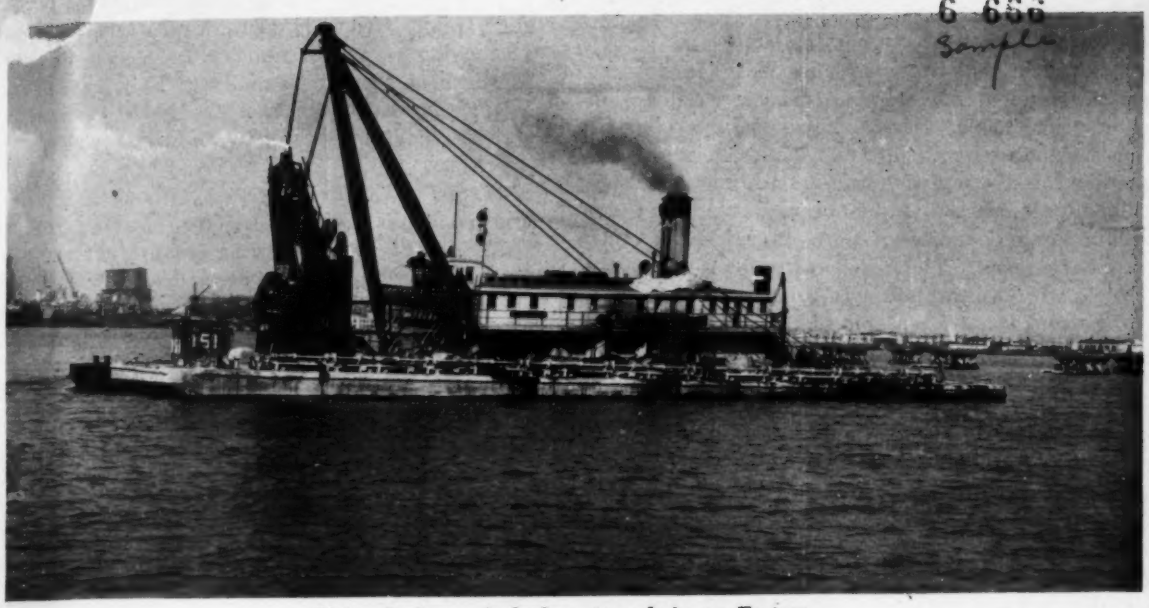

Pictured above: A dredge at work in an Eastern seaport.

Sedimentation in a Great Harbor

By L. C. GOTTSCHALK

History holds many examples of once prosperous ports and harbors which declined and disappeared as a result of sedimentation. Adria in Italy, which gave its name to the Adriatic Sea, was an important seaport in the time of Caesar Augustus. It is now 20 Italian miles inland. Tarsus in Cicilia, once visited by Cleopatra's fleet, is now 10 miles inland from navigable waters. Surat, once the leading commercial center of India, dropped in population from 800,000 inhabitants in 1797 to 80,000 in 1847, because its port on the Tapti River became filled with sediment. Historians, geologists, and engineers alike have been almost universally guilty of attributing the rapid filling of these ports to the inexorable forces of nature. They have failed to perceive the vast changes in rates of erosion brought about by man's deforestation and his agricultural use, or misuse, of the land on tributary watersheds.

Few persons, perhaps, realize that many ports of importance in the Colonial era of our own country suffered a similar fate, or that many of our major ports of today function only because of continuous and expensive dredging operations. In the Chesapeake Bay area more than a dozen important Colonial settlements in Maryland and Virginia became ghost towns when ships could no longer reach their landings. Joppa Town on the Gunpowder Falls; Elk Ridge Landing on the Patapsco; Piscataway on Piscataway Creek; Bladensburg on the Eastern Branch of the Anacostia River; Port Tobacco on Port Tobacco River; Dumfries on Quantico Creek—all these and others fell into decay when their navigation channels became filled with sediment.

Rapid sedimentation in the embayments and navigable rivers of the Eastern Seaboard is an abnormal condition that developed after white men settled this region. Both historical and geological evidence indicates that the preagricultural silting of tidal estuaries was very slow. There is a startling contract between what one sees along the Potomac River today and its appearance in 1634, as thus described by Father White, an early missionary to the Indians:

> This is the sweetest and greatest river I have ever seene, so that the Thames is but a little finger to it. There are noe marshes or swampes about it, but solid firme ground, with great variety of woode, not choaked up with undershrubs, but commonly so farre distant from each other as a coach and fower horses may travele without molestation. The soyle is so excellent that we cannot sett down a foote, but tread on Strawberries, raspires, fallen mulberrie vines, acchornes, walnutts, saxafras, etc. and those in the wildest woods. The ground is commonly a black mould above, and a foote within ground of a readish colour. All is high

EDITOR'S NOTE.—The author is associate geologist, sedimentation section, Soil Conservation Service, Washington, D. C.

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woods except where the Indians have cleared for corne. It abounds with delicate springs which are best drinks. * * *

The rapid exploitation of this country for tobacco culture resulted in widespread and severe soil erosion even prior to 1700. Several ports had already become ghost towns by this date due to the effects of soil erosion. Of the many original towns established along the shores of the Chesapeake Bay during Colonial times only one—Baltimore—ever developed into a great seaport. The history of its long and costly battle with sedimentation to achieve and maintain its present status is an epic of the effects of uncontrolled erosion since the date of wholesale land clearing and cultivation more than two centuries ago.

Baltimore was officially designated a port of entry by the General Assembly of Maryland in 1706. Within 40 years it became the most populous and wealthy town of the Province. It was incorporated as a city in 1796. Today it is the seventh largest city in the United States and is known the world over as a great industrial center and shipping port. Its harbor is one of the busiest on the eastern coast, with a normal water-borne commerce of 18,000,000 tons annually, of which 30 per cent is foreign trade.

What is generally called Baltimore harbor consists of the parent estuary of the Patapsco River and the arms formed by minor tributaries. When Captain John Smith first saw the Patapsco, in 1608, the limit of open tidewater was 7 miles farther inland than it is today, and to him it must have presented the appearance of an excellent harbor. Indeed, the first landing established on the Patapsco estuary was near the head of navigation at a point called Elk Ridge, which became a prosperous town before the first house was erected in Baltimore. Ships sailed to Europe from Elk Ridge Landing, loaded with tobacco and other products.

In 200 years or more, the head of navigation has been pushed progressively downstream from Elk Ridge Landing to the Hanover Street Bridge at Baltimore, a distance of six and three-quarters miles. As late as 1845, according to charts of the U. S. Coast and Geodetic Survey, the maximum depth of water at mean low tide immediately below the bridge and adjacent to the left bank of the stream was 17 feet. By 1898 this depth had been reduced by sedimentation to 3½ feet, and by 1924 to about 6 inches. Dredging near the mouth of the Patapsco River several years ago recovered a bottle labeled in 1905 from beneath 5 feet of sediment.

Baltimore Town was founded at the head of the cove formed by Jones Falls. Originally the cove was called "Coles Harbor," but later it became known as "the basin." Sedimentation in the basin apparently was active by the time the town was laid off, for a plan dated 1730 shows extensive alluvial deposits, known as Harrison's Marsh and Steiger's Meadow, at the mouth of Jones Falls east of the town. The basin has been changed extensively as well as maintained for two centuries by dredging operations.

Jones Falls drains an area of 50 square miles of Piedmont soils, and cascades down the "fall line" directly into the basin, carrying large volumes of sediment from the cultivated lands above during each flood. Early accounts of Baltimore carry detailed descriptions of the numerous and devastating freshets which occurred on this stream. Mill dams and bridges were washed out periodically while the flood waters carried parts of buildings, carts, whiskey casks, as well as sediment, into the basin.

Sedimentation in the basin received official cognizance as early as 1753, for in this year it was enacted that:

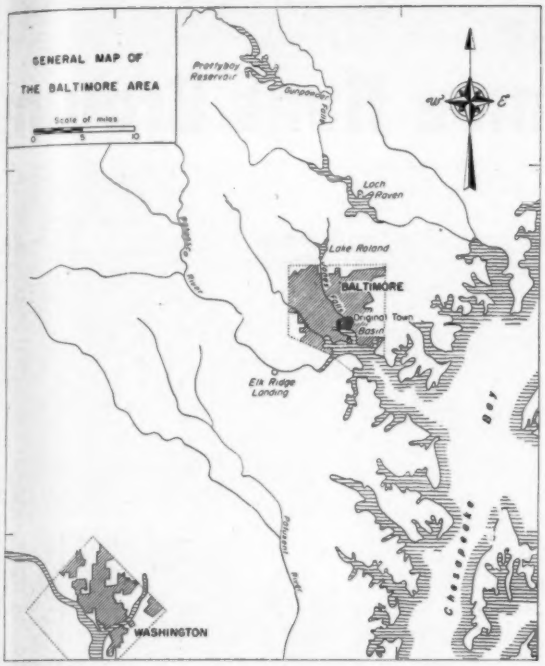
> * * * no earth, sand or dirt was to be thrown into or put upon the beach or shore of the Patapsco River, or any navigable branch thereof below high-water mark, unless secured by stone walls, dove-tailed log-pens, &c., from washing into the river, under a penalty of five pounds of current money.

During the period 1750 to 1764 boom town construction took place about the port. Numerous private wharves were built, some a thousand feet or more in length. In 1753 a shipyard was in operation in the bend of Jones Falls north of Baltimore town. At that time, there must have been sufficient depth in the channel of Jones Falls, as it meandered through Steiger's Meadow and Harrison's Marsh, to permit passage of completed ships to the basin and finally to the estuary of the Patapsco. The area above the basin has long since been filled in and the famed Battle Monument now stands on the site of the old shipyard.

A visitor to Baltimore in July 1762 wrote:

> * * * There are 2 Bridges over the creek [Jones Falls] which Joyns the 2 Parts of the Town together the Creek is shoal that only Boats or Flats can go up, & runs such a short distance in the Country that there is but very Little Currant to keep it clear so that its my Opinion both that & Bason to the S. of the Town must in a Few Years be Choak'd up Except a small Stream that the Creek which they call the Falls will keep open sufficient perhaps for Flat Bottom Craft & in that case the Sea Trade will draw down to a point Call'd Fells Point where the Shipping now Lye there being at this time 3 Ships & a Snow from London Loading with Tobacco.

His prediction was fulfilled, for the sea trade did finally draw down to Fells Point, where, as late as 1800, there was still a depth of 18 feet. In 1783 port wardens were appointed to make a hydrographic survey of the basin, harbor, and Patapsco River to determine the depth and course of the channel and provide for cleaning it. To defray expenses, one penny per ton was levied against every vessel entering or clearing the harbor. The hydrographic sur-



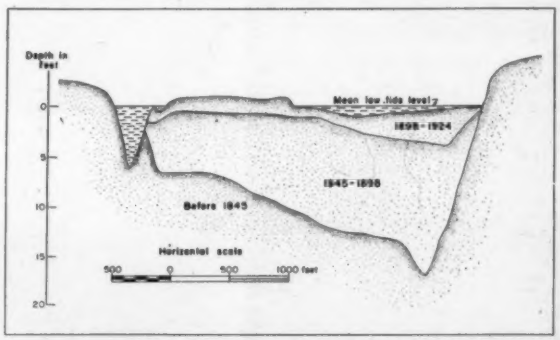
vey which was completed in 1799, showed that the water in the basin was only 8 or 9 feet deep.

Chroniclers have given Baltimore credit for developing the first "mud machine." This is probably in reference to the work done by the enterprising Ellicotts of flour mill fame, who, in 1783, extended their wharf by dredging sediment from the bottom of the port and using it for fill. Their equipment consisted of a drag with a team of horses and iron scoops with windlass.

By 1799 there were 170 warehouses in Baltimore. Fifty capital merchant mills, a powder mill, two paper mills and several furnaces and forges were located within 18 miles of the town. The value of exports amounted to more than $12,000,000 annually and the arrivals and clearances of ships, brigs, sloops and schooners and "bay craft" were counted in the thousands, for Baltimore had become the third commercial city of the United States.

With the increase in number and size of vessels, it became imperative that the navigation channels be improved and kept open. In 1815, the city authorities passed a resolution to sanction deepening of the bed of Jones Falls. The Federal Government began dredging operations in Baltimore harbor in 1836. In 1852 the Fort McHenry channel from the city limits to a point just below Fort Carroll, and the Brewerton channel from this point to deep water in the Chesapeake Bay, were dredged by the Federal Government in cooperation with the city of Baltimore. These channels, when completed, were 150 feet wide and had a minimum depth of 22 feet. They were enlarged in 1872 to provide a depth of 24 feet, a width of 400 feet in the lower end of the channel and 250 feet in the upper end. By 1881, thirty years after original dredging began, the Brewerton channel was found to be filling rapidly with sediment. Finally it was abandoned entirely and a new channel dredged, which followed the natural thalweg of the Patapsco River. The cost of the new channel was $1,250,000 and subsequent enlargement of it in 1896 cost another $2,250,000.

During the past 100 years the Federal Government alone has removed more than 111,000,000 cubic yards of material from Baltimore harbor, at a cost of nearly $17,000,000. Of this amount, $12,000,000 has been for new channels, necessitated in part by silting of old channels while $5,000,000 has been for strictly maintenance dredging or removal of sediment from existing channels. In addition, a substantial amount, probably measured in terms of millions of dollars, has been spent by private interests and by the City of Baltimore for channel improvement and maintenance. As early as 1852, Baltimore had in operation a dredging machine reported to have cost $70,000. In 1872, 13 dredges were in operation at one time in Baltimore harbor.



Sedimentation of the Patapsco River arm of Baltimore Harbor near Hanover Street bridge.

The cost to the Federal Government of maintenance dredging in Baltimore harbor from 1934 to 1941 was over $1,000,000, involving the removal of nearly 15,000,000 cubic yards of sediment. The amount of required maintenance dredging in this harbor appears to be on the rise, for the Patapsco River sediment, which formerly was deposited, to a large extent, in that part of the Patapsco estuary between Elk Ridge Landing and the present harbor, now has almost completely filled this natural basin.

Soil erosion in the watersheds tributary to the Patapsco Bay undoubtedly accounts for the major

(*Continued on p. 11*)

Fish and Farms Suffer when the Maumee Runs Brown

1. Erosion following heavy rains in April 1944; 3 percent grade. This is south of Ohio 81, west of Allentown, in Allen County, Ohio.

2. Wave-notched south shoreline of Sandusky Bay, Erie County, as seen in April 1944.

3. Gullying from barnyard and stock lane beside Bean Creek. Williams County, spring of 1944.

4. South shore of Sandusky Bay, showing removal of soil by waves; summer of 1943.

5. Hog wallow ruined creek bank in foreground; fence-protected shrubby bank presents contrast. Bean Creek, April 1944.

6. Turfed 4-to-1 sloping ditch bank beside U. S. 127, south of Paulding, Ohio. Foreground turf has been burned over. April 1944.

In this article the director of a famous biological laboratory points to the relationship between soil erosion and the valuable fish resources of Lake Erie.

By THOMAS H. LANGLOIS

The flat lands of the northwestern section of the state of Ohio, once the bed of glacial Lake Maumee, were covered with swamp forests in the early eighteen hundreds. Pioneer settlers passed the area by as one where the fever and ague were prohibitive to human health. The ditch-digging Irish immigrants of the 1850's changed conditions, draining off the brownish swamp waters into the tributaries of the Maumee River and clearing off the low-land forests. The Germans who came to Ohio in great numbers from 1860 to 1880 took over the area, and their descendants now form the bulk of the population of this section of Ohio.

The land is so nearly level that the annual rainfall of 36 inches makes agriculture impossible unless runoff is accelerated. The area is a maze of ditches which are fed by bedding furrows and field tiles, and the rich farms produce great quantities of corn, oats, wheat, soy beans, sugar beets, and clover. Unfortunately, the methods used to produce some of these crops leave the soil without cover during critical rainfall periods, and a huge loss of some of the richest soil in our country is occurring. This is appalling to people who recognize the soil as the basis of our national economy, and it should become a matter of grave concern to the husbandmen of the area.

The material lost from the surface of these flat, rich farms is carried by the water from the ditches and small creeks into the larger branches, and it goes down the Maumee, Portage, and Sandusky rivers into the west end of Lake Erie. All of these streams have been widened where they enter the lake into broad, flat, estuarial bays, and the silt carried into these bays during the last two or three decades has greatly changed the physical and biological conditions.

Within historic times these bays have been famous duck feeding grounds and nesting areas, and they have been of inestimable importance as breeding and nursery areas for many of the valuable food fishes of Lake Erie. Submerged beds of aquatic vegetation were then abundant throughout the bays, and they played an important role in producing the multitudious forms of insects, worms and snails which young fishes require for food. They also served to stop waves from violently cutting away the shores of the bay, and stirring up the bottom mud.

EDITOR'S NOTE.—The author is director of the Franz Theodore Stone Laboratory, Put in Bay, Ohio.

There is a delicate balance between aquatic vegetation and turbidity, and this balance can shift to favor either side of a very real conflict. Aquatic vegetation thrives in clear water and it tends to maintain clear water by holding down the bottom sediments, by preventing wave cutting of shore lines, and by filtering materials out of suspension in the water. Turbidity works for greater turbidity by smothering and shutting the light away from the vegetation. When the vegetation has been killed off, the bottom materials are brought up into renewed suspension, while the unimpeded waves cut back the shorelines and add new materials to roil the waters further.

In the bays of the southwest end of Lake Erie, the balance has shifted to favor turbidity. The heavy silt loads of the streams entering these bays has smothered and eliminated aquatic vegetation. The bottoms now are brought up with each strong wind, and the waves are cutting the shorelines back with disastrous effects. In Sandusky Bay, an early record shows Eagle Island on the tax duplicate as having 149 acres. In 1944 there is about one acre left, the rest having been spread over the bottom of the bay or carried on out into the open lake. One place under observation on the south shore of Sandusky Bay is being cut back by waves as much as 20 feet per year, and has recently taken out the bayside road. Maumee Bay has been made a near biological desert in the same way, and so has the mouth of the Raisin River, nearby in Michigan.

These effects are not limited to the bays mentioned here. The muddy waters of these south shore streams reach out around the lower islands of the Erie archipelago. The turbidity of the water between South Bass Island and Rattlesnake Island has been found to vary directly with the amount of water discharged into the lake by the west end streams during the spring months which are so critical in the life of all species of fishes in Lake Erie.

The commercial catch of food fishes in the Ohio waters of Lake Erie has shown the effects of this land misuse up the valleys of the tributary streams. Until 1924 the mainstay of the fishery was the herring, a species which feeds throughout its entire life span on small floating organisms (plankton). These small plants must have sunlight, and light cannot penetrate roily waters. Normally, these small plants and small animals reach a peak of abundance during the spring months when most fish eggs hatch, and

when food for the young fishes must be abundant or the young do not survive. The increasing silt loads of these west-end streams have changed conditions so radically that the herring has been eliminated as a commercial species, and the perch, which requires areas of vegetation for spawning for the growth of its young, has greatly diminished in abundance.

The yellow pickerel is somewhat more tolerant but shows the effects of changing conditions in different ways. The rapids of the Maumee River above Toledo were once a great spawning area for yellow pickerel, and the pickerel run from the lake up the Maumee and several other west-end streams to spawn shortly after the ice goes out in the spring. During spring seasons of low rainfall, such as 1926 and 1941, the streams run clear and great numbers of young pickerel are produced, but during the more usual years when the streams run high during March, April, and May, with melting snow and heavy rainfall, few young fish are produced. Naturally the catch by the commercial fishermen drops off after a series of years like this, and unfortunately they are then blamed for depletion by over-fishing. Obviously, however, they cannot catch fish which could not hatch and survive to enter the catch.

Fortunately, there are some species of fishes which can exist and even thrive in roily water, and these species (saugers, sheepshead, catfish, buffalo, and carp) are now constituting a large share of the total catch by Ohio fishermen in Lake Erie. However, these are second choice species and an increase in the abundance of the first choice species would be worth the expenditure of considerable effort.

At the Franz Theodore Stone Laboratory (a department of the Ohio State University, located on South Bass Island, 50 miles from the mouth of the Maumee River) regular analyses of the lake water have been made throughout the last few years. Farmers of the northwest section of Ohio would feel hurt if they could see how the nitrates from their fields are carried with the heavy spring run-off out to fertilize Lake Erie. The graph of nitrate abundance in Lake Erie is a record of farm losses which ought to be stopped. There is not yet one soil conservation district in this part of Ohio, but the losses are greater than those caused by the more spectacular gullies of the hill regions. The farmers somehow must be given an awareness of the problem and a concern for it, and help in applying methods of correction to their farmlands—such techniques as contour plowing, strip cropping, controlled grazing, and better ditching.

Ditches are essential to any land use because the land is so nearly level, but ditches can be made to carry more water by widening instead of deepening, and the banks can be given slopes of 3 or 4 to 1 and covered with turf to stop bankwash. The malpractice of burning ground-covering turf should be discouraged, to keep the cover as well as to avoid compacting the soil. Tightly packed soil—accelerated by burning—speeds the water away, while loose soil retains it for plant use later in the season when rainfall is scant.

The farm practice of permitting stock to graze to the water's edge, denuding creek and ditch banks of protective vegetative cover, is very common—and very disastrous. So, also, is the practice of giving barnyard stock direct access to the stream into which the barnyard drains as the principal means of supplying water to the stock. Stream banks are too frequently left unfenced and otherwise unprotected.

There is much to be done by Ohio farmers on pond and cistern construction to bring about greater convenience in the watering of livestock, to make better use of such water as is available, and to minimize the destruction of the soil resource. Likewise, there is a great deal to be accomplished in providing protection to creeks from the harm wrought by hog wallows and overgrazed banks.

(*Continued on p. 15*)

NEW ANGLE FOR SOLVING LEGUME SEED SHORTAGE

The disastrous shortage of legume and grass seeds this year has focused attention on an Ohio State University Experiment in bee pollination of clovers, which forecasts up to 1,500 percent increase in seed production.

With the national yield of red-clover seed at less than 1 bushel to the acre last year, the 12-bushel yields found possible with full pollination by honeybees should be attractive, say the departments of zoology, entomology, and agronomy of Ohio State University in a new bulletin. In the case of alsike clover, the yields went up from 1½ bushels to 20 bushels.

Most clovers are self-sterile, say the Ohio scientists, and are propagated almost entirely by insect life. What is not generally realized is the dominance of the honeybee. A 3-year study, just completed, shows that actual pollination of red clover was accomplished by honeybees in 82 percent of the cases, with bumblebees doing the work in 15 percent and other insects making up the remaining 3 percent.

The bulletin suggests that farmers everywhere take advantage of existing bee yards by growing clover crops in close proximity to them so as to "step up legume seed production" and be in line with the "save seed for victory" campaign. It is even suggested that "for purposes of heavy seed production, it may be desirable to increase the honeybee population to a degree where honey production becomes unprofitable," in order to provide the 100 percent pollination.

BLASTING FOR FOOD

Five hundred feet of drainage ditch at one blast! The sprinkler irrigation line in the foreground will be needed in the dry midsummer months when pastures wither even in this belt where 90-odd inches of rain falls annually.

By CARL P. STEVENS

Some sectors of western Washington's "farm front" have taken on a realistic military aspect the past year. Farmers in the important dairying sections of Grays Harbor County and nearby areas have been resorting to explosives to blast drainage ditches through hundreds of swampy acres and make them fit to grow pasture and hay crops.

Dynamiting this year started hundreds of additional gallons of milk flowing to the big Fort Lewis army base and other major West Coast war markets. By the turn of the 1944 spring growing season, not fewer than 15,000 feet of ditches had been blown neatly across previously useless or, at best, low-producing lowlands. They had brought some 1,200 acres into productive condition in the Montesano-Elma-Oakville Soil Conservation District alone.

Floyd Sherwood, head of the Sherwood Creek Drainage Association, organized to take advantage of assistance from the district and from the cooperating Soil Conservation Service, put it this way:

"This gives us a chance to increase our milking herd. We have had quite a time in the past getting enough pasture, and cows produce heavier on better pasture. The drainage doubles the land that can be tilled when we finish clearing, and it hasn't cost us as much as we expected. The way it has been, it was too wet even to clear. This last winter there has been no water on there at all; it found its way into the ditch."

Sherwood has 102 acres, 65 of which will bring him the extra feed he needs for the 45 cows and heifers he and son Amile take care of unassisted. His aim is to step up his actual milkers to 35 from the 25 to 30 that he milks now. He ships to Fort Lewis.

Others have had happy experiences with the new way of ditching—Albert Valentine, Ben Smith, Les and Fred Mouncer, Pete Hansen and James Dickinson. It was they who prevailed upon District Supervisor Chairman W. D. Olsan, Vice-chairman Clarence Glenn and Supervisor Harry Swenson to bring about the wizardy of dynamite drainage on lands that were too boggy for ordinary ditching machinery to tackle. It was they who noted past drainage accomplishments under more conventional methods.

They had heard P. L. Lavender say that the earlier Wenzell Slough drainage south of Elma had increased his pasture by nearly 100 animal months a season. They had heard C. O. Osgood state that on 75 acres of his woodland pasture, once totally unproductive, he is now getting 228 animal months pasture a season.

The farms of this one group alone total nearly 450 acres, of which 185 acres was totally unproductive because of lack of drainage. District engineers' surveys showed a need for a 6,000-foot main ditch and 4,000 feet of lateral and tile drains. The farmers lost no time in buying three tons of dynamite. After

EDITOR'S NOTE.—The author is District Engineer, Soil Conservation Service, Montesano, Wash.

two days' instruction by technicians, they went ahead with ditch blasting on their own. How well they did the job was borne out during the 1943–44 winter "flood" rains, when the then still uncompleted main ditch carried off all surplus water without any flooding of adjacent land.

Or take the defunct Drainage District No. 2, also in Grays Harbor County. A 20-year-old drainage system virtually had ceased to function. The ditches had been allowed to clog with brush and weeds. Reorganized by a dozen farmers operating 567 acres, this drainage district similarly went to work with dynamite to do most of the cleaning job. As on Sherwood Creek, some ditching had been done by farmers with their own tractors and scrapers. Restoring 4,000 feet of the old ditch to working order means these war food producers are able to get into their fields weeks earlier and increase their yields proportionately.

One of the first dynamite ditching projects completed was on the 340-acre Marie Wolfisberg place near Elma, on which some 60 acres were too wet to farm profitably. The owner personally placed and tamped the special, 50 percent nitroglycerine blasting dynamite in the holes punched by Chris Studer and Fritz Wolfisberg for shooting the 2,400-foot main ditch, 4 feet deep, 6 feet wide at the bottom and 14 feet across the top. She figures on being able to farm six weeks earlier in the spring. The drainage affords 40 additional animal months of pasture.

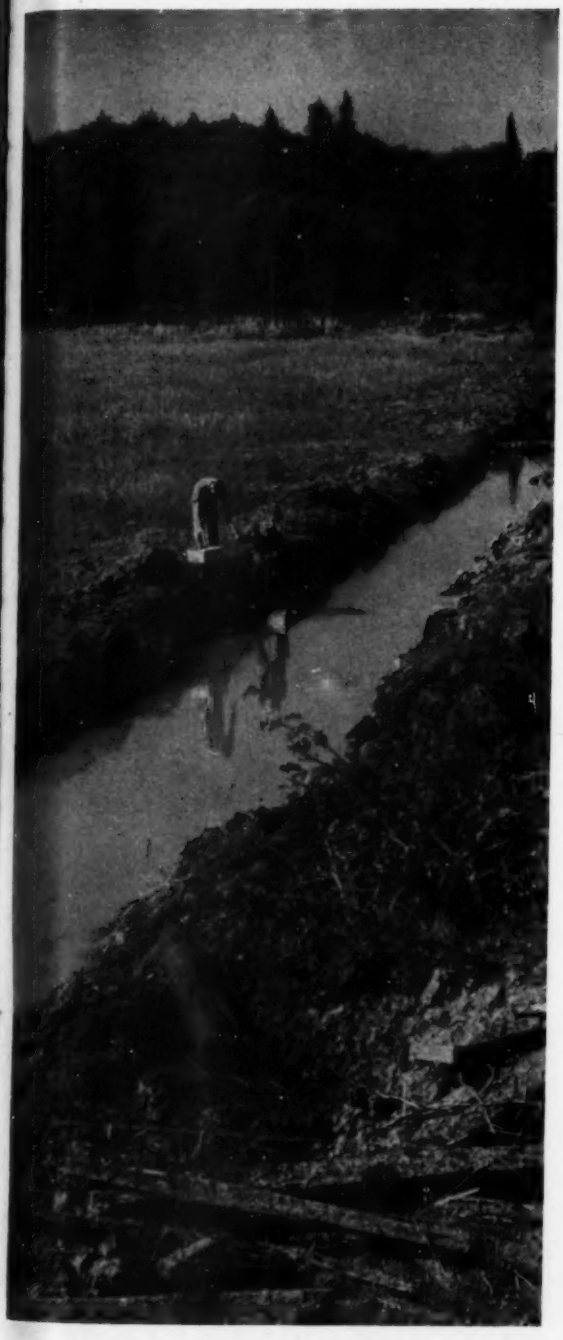
These are representative of numerous low-cost individual and group ditching undertakings completed or under way in the Montesano-Elma-Oakville district. Though soil types and other conditions vary the dynamiting technique and the expense, the Sherwood Creek ditching, for example, showed an average powder cost of only 19 cents and labor outlay of only 10 cents a lineal foot. The cash cost of the Wolfisberg 2,400-foot ditch was exactly $307.22, or 9 cents a cubic yard, not counting the owner's own labor.

On the latter project, the three farmers were able to load and shoot as much as 500 feet of ditch in one 8-hour day. This ditching dynamite shoots by the propagation method in moist or wet soil, with the only equipment used comprising district-supplied "T" punch bars, a small electric detonator and 300 feet of blasting wires. *It enables shooting at safe distance with a single cap to set off a whole line of loads.*

The farmers not infrequently have sizable audiences, interested at once in the spectacle of a line of wet, black soil skyrocketing 200 or 300 feet in the air and in the practical possibilities of the ditching process.

The newly blasted ditch before smoothing and finishing.

Successful dynamite drainage, of course, is but a means to the all-important end of improved cropping



Unwanted water on its way.

and better production. This is accomplished through such further conservation practices as approved pasture seeding, harrowing and mowing, rotation grazing and the use of fertilizers.

SEDIMENTATION IN A GREAT HARBOR

(*Continued from p. 5*)

part of the cost of maintenance dredging in Baltimore harbor. It is estimated that the Patapsco River and tributaries currently carry more than 16,000,000 cubic feet of sediment into the harbor each year. If all of this were deposited in navigation channels, the average annual cost of removing it, at prevailing contract dredging prices, would be nearly $100,000 per year. The current Federal cost of maintenance dredging in Baltimore harbor is estimated by the U. S. Army Engineers to be $150,000 annually, but this probably includes overcoming past failures to "keep up" with the rate of silting as well as removal of sediment in the lower harbor which may come from the Susquehanna River.

Baltimore's sedimentation problem has not been confined to its harbor. For many years sediment seriously interfered with development of a dependable water supply. The city's first water supply reservoir, Lake Roland, was built on Jones Falls in 1862 with a capacity of 400 million gallons. Within 10 years the city was forced to begin sediment removal. By 1900 more than 434,000 cubic yards had been dredged from the lake at a cost of over $83,000. The reservoir was finally abandoned as a source of water supply in 1916.

In 1881 the city constructed a second reservoir—Loch Raven—on Gunpowder Falls at a cost of $321,000. The original storage capacity of 510 million gallons was reduced to 78 million gallons by 1900, despite the fact that 500,000 cubic yards had been dredged from it between 1896 and 1900. Dredging of the reservoir continued up to 1912 by which time an estimated 2,200,000 cubic yards, altogether was removed at a cost of $400,000. In 1912 a new and higher Loch Raven Dam was started. This dam was raised in 1922, and in 1933 another large reservoir was created upstream by the completion of Prettyboy Dam. These reservoirs are silting slowly only because their enormous storage capacity—a total of over 41 billion gallons—is developed in a relatively small watershed of 303 square miles. The rate of sediment production in the watershed is actually well above the average for the Southern Piedmont, a region of notorious soil erosion. Recent surveys of these two reservoirs show that a total of 9,600,000 cubic yards of sediment has been deposited in them since construction.

Equally severe sedimentation damages have caused partial or complete loss of value of other reservoirs in the Baltimore area, such as the 30-foot Illchester dam and the 30-foot Avalon water supply dam on the Patapsco River, the Woodlawn Cemetery Lake,

the Gwynn Oak Park Lake and many mill dams.

Soil erosion has been costly to farmers as well, for example, the 9,600,000 cubic yards of the sediment in Loch Raven and Prettyboy Reservoir is derived mostly from cultivated land which occupies about one-third of the drainage area above these dams. It, therefore, represents roughly the removal of 1 inch of surface soil from this land, exclusive of eroded material which has come to rest below slopes and in the valley bottoms. Studies by the Soil Conservation Service in the Corn Belt indicate that the removal of 1 inch of topsoil from a field will reduce corn yield by 5 bushels per acre. If the fertility of soil in the Gunpowder Falls watershed has decreased to a point where it would produce, on the average, only one bushel less per acre, then the loss in farm income, based on reduction of corn yields in 30 years, has cost the farmers in this watershed nearly a million dollars. The aggregate loss to farmers in the Patapsco watershed above Baltimore harbor has been even greater.

The city of Baltimore lately has been authorized by the State to incur an indebtedness of $50,000,000 for the development of the port. During the post-war period the United States will possess the greatest merchant marine in the history of this country, and probably in the history of the world. The future of Baltimore is auspicious. There is no doubt that the navigation channels of this port can be kept open by dredging to accommodate a vast post-war trade, but the wiser and most economical course would be to install complete soil conservation measures on the watershed. From experience and comparative cost data we know that it is easier and less costly to hold a cubic yard of soil on the land than it is to raise it from the bottom of a harbor, or a reservoir, and transport it, often many miles, to an isolated dumping ground where it can do no further damage.

Too little is known at present of the economics of soil erosion in relation to reservoir and harbor silting. In this connection research studies are needed to determine the nature, location and extent of erosion-control measures necessary in particular watersheds to achieve maximum reduction of harbor sedimentation with a minimum expenditure. Preliminary studies in the Patapsco River watershed indicate that approved conservation practices such as gully control, strip cropping, stream-bank protection, terracing, contour plowing, crop rotation and other measures, which can be fitted into the farm economy, would result in a substantial reduction of dredging costs in the harbor as well as very large benefits to the farmers and landowners. The sediment inflow to Baltimore harbor is conservatively estimated to be about 600,000 cubic yards annually. About 90 percent of this is derived from approximately one-third of the drainage area, mostly from the cultivated land. The total installation cost of erosion-control measures in the sediment source areas, plus maintenance for 25 years, is estimated to be about $750,000. With a well planned and carefully executed program, it is estimated that the sediment inflow from this area could be reduced by nearly 75 percent which, at prevailing contract dredging costs, would amount to a savings of $60,750 annually to the Federal Government alone. On the basis of benefits received solely from reduced dredging costs, this program, which should require no longer than five years to complete, would pay for itself in a little more than 12 years from date of completion. Over a period of 25 years, it would not only pay for itself, but would save the Government three-quarters of a million dollars besides. Add to this the many physical and economic benefits to be received by the farmers; by the owners of storage developments and by others, and the program would actually pay for itself, in value received, in but a few years.

KUDZU DONOR DE LUXE

A. J. Hilton, owner and publisher of the *Banks County Journal*, Homer, Ga., got the surprise of his life recently when one of his readers sent in a paid advertisement announcing that he had some kudzu crowns that he would give to anyone who would dig them. In a front-page story Mr. Hilton said:

"We've been fooling around with the advertising business several years, but never before last Monday did we receive a check to advertise something to give away. Bob Sanders knows what a great benefit kudzu will be to this country, and he wants to help the land and his fellowmen. His letter follows:

"'DEAR MR. HILTON: I have several thousand kudzu crowns that I want to offer free to any person in Banks County—all I ask them to do is to come and dig them.

"'Now if you will promise to dig them for any woman that's not able to dig them, I will help you take them up for her. Now, if this is not a bargain, what is a bargain?

"'I have been advertising for some 40 years and paying for the ads, but now I am willing to pay for an ad to give away kudzu crowns, as I believe kudzu is the best cover crop and hay crop we have in this country. I have lots of gullies that need filling up, and I am trying to get help to set out kudzu crowns on this land.

"'With kindest regards.

(Signed) "'BOB SANDERS.'"

This is the sales yard maintained by the marketing organization which the farm forester helped farmers organize. Farmers deliver their wood products here and receive their money on delivery.

CONSERVATION RIDES TIMBER TRAIL IN TURTLE MOUNTAINS

A wood splitter developed by members of the Turtle Mountain woodland association. One man and a helper can split about 1¼ cords of fuel wood per hour with this machine.

By WALTER H. PAUL and ELMER L. WORTHINGTON

Farmers in northern North Dakota's Turtle Mountains set up a forest products market three years ago. Their intent was to furnish an outlet for their timber. Actually, they provided as well the incentive for needed land use adjustments and other features of conservation farming.

The market succeeded and broadened. With woodland improvements made worthwhile, cattle had to be moved. Now, brush land is being cleared and other land, retired from cultivation, is being seeded to grass for needed new pastures. Development of stock water supplies, crop rotations, and tillage and cropping practices to prevent erosion followed naturally.

Notable also is the market's satisfying of both seller and consumer. Even before the present wartime market, the consumer, assured of a uniformly good product, doubled the price paid to the farmer and assured him of ready sales. The farmer, knowing that he can deliver his wood at his own convenience to the market at a uniform price, provided he maintains specified grades, finds his woodlands worth maintaining and improving.

This happy opportunity springs from the establishment by the Soil Conservation Service of a farm forestry project in 1940, followed in 1941 by the organization of the Turtle Mountains soil conservation district by the farmers. Soil Conservation personnel are now very busy helping to develop farm conservation plans.

Low-lying hills 400 to 600 feet high, the Turtle Mountains occupy a quarter of a million acres south of the Canadian border. Slopes are gently rolling to steep, some too steep for cultivation. Half of the area is woodland, of which 85 per cent is pure aspen, 12 per cent mixed hardwoods, 3 per cent bur oak. Adjacent is a large almost treeless plain which ships nearly all of its lumber and many of its posts from Oregon, Washington and Minnesota, and is a market for fuel wood to supplement the lignite coal mined there, lumber for farm buildings and rough construction generally, props and ties for the lignite mines, and fence posts. Most of the Turtle Mountain farms are classed as livestock-cash grain units. The average size is 294 acres, of which 163 acres is woodland.

Earlier, Turtle Mountain farmers depended on forest products sales for a substantial part of their

EDITOR'S NOTE.—The authors are the farm forester and district conservationist, Soil Conservation Service, Bottineau, N. Dak., respectively.

incomes. Marketing was unorganized, with no systematic effort to capitalize fully on the existing market or to develop its potentialities. Came the depression, and this manner of marketing floundered. There followed a long period when the farmers did little or nothing with their woodlands. There was no way to bring seller and buyer together. Often a farmer brought a load of wood when he came to town, only to haul it back unsold. It wasn't the right day. The market was further harmed by farmers too often supplying poor quality products. Returns did not justify expending much effort on the woodlands. Pasturing them heavily became the rule.

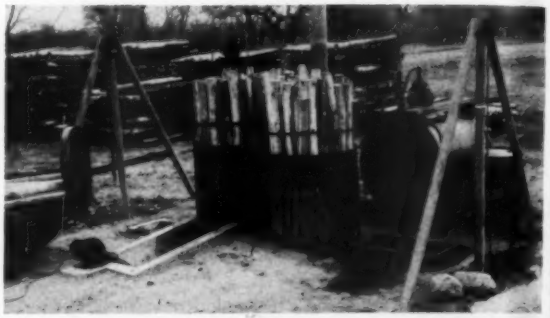
That was the situation when the Farm Forestry Project was initiated. The farm forester started some demonstrations first, then concentrated on cracking the market situation. With his help, the farmers in five townships organized the association which set up the present market. Each township elected two directors, from whom the officers were chosen. The directors selected an agent to buy and sell forest products on commission. The agent's commission was the association's sole operating expense, since he furnished the sales yard at Bottineau, the area's principal market place. The local cooperative creamery donated the use of a $1,000 revolving fund for operating capital.

The sales yard buys fence posts and fuel wood on a graded basis from any farmer, paying approximately 80 percent of the price for which the agent expects to sell them. Any difference between purchase price, plus the agent's commission and the sale price is paid to the farmer at the end of the year on a patronage basis.

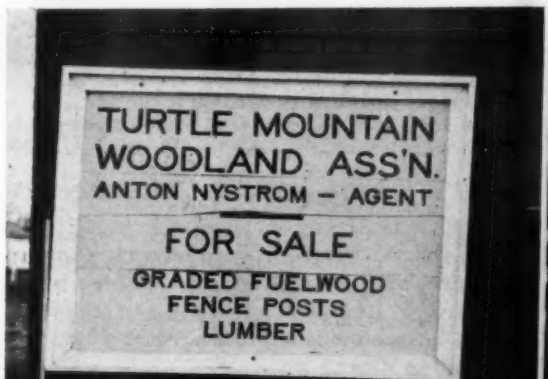
During the first year, 1942, the sales yard handled 19,000 fence posts and 300 cords of fuel wood, and last year 25,000 fence posts and 150 cords of fuel wood. Indications are that in 1944 business will exceed the total for the first two years.

Now, the association has a plant to treat aspen posts with creosote, using the hot-and-cold-bath method. An incising machine made from a trip-hammer is part of the plant, necessary because aspen posts case-harden. Last year, 3,500 posts were treated. The demand is so active that this year the association is buying 30,000 posts for treating. This has vastly improved the market for forest products from the Turtle Mountains, since aspen brings a better price as posts than sawed up for fuel. Treated, aspen posts last 15 to 20 years; untreated, 2 or 3 years. The treating mixture is 40 percent creosote, a by-product of lignite briqueting in North Dakota, and 60 percent fuel oil. Perforating the posts ½-inch deep on a 24-inch section, half above and half below the ground lines, gets satisfactory treatment.

General view of the Turtle Mountains in north-central North Dakota, where the farm forestry project helped farmers break a marketing bottleneck. This, in turn, has increased the interest in woodland management and also opened the way for a broader soil and water conservation program.



The post treating plant which has been established by the Turtle Mountain woodland association has broadened the farmers' market for wood products. Timber suitable for the purpose brings more when marketed as posts than as fuel wood.



The sign at the service station operated by Anton Nystrom, who handles the purchase and sale of wood products for the woodland association. Since Nystrom furnishes the sales yard, his commission is the only sales expense.

Farmers, too, are developing equipment. One piece is a wood-splitting machine made from the drive wheel of a steam engine and powered by a 1½-horse-power gasoline engine. With it, one man and a helper can split about 1¼ cords an hour.

The labor situation has impelled the association to shelve its other development plans, which include a good sawmill and emphasis on the production of local lumber. However, it was incorporated under the North Dakota laws last year to assure its own working capital. Shares are sold to woodland owners at $10 each. A working capital of $2,000 is required for the existing fuel and fence posts business, while $5,000 is estimated as needed to bring planned developments to reality.

Clearing of the brush-covered lands is going ahead rapidly, both the market association and soil conservation district helping in this, to compensate for the reduction of grazing in the woodlands. Clearing is done in winter when the ground is frozen, at a cost of a little more than $5 an acre. Pastures already developed in this way have greater grazing capacity than the woodlands they replace, thereby increasing food production for war.

Still another dividend has accrued to the Nation, in addition to getting needed land used adjustments, the development of formerly idle lands, and conservation farming in the Turtle Mountains. Now, when the railroads are heavily burdened in transporting men, arms and munitions, the increased use of these home-grown forest products lightens the transportation load by just that much.

REVIEWS

CONSERVATION IN THE UNITED STATES. By A. F. Gustafson, C. H. Guise, W. J. Hamilton, Jr., and H. Ries. Cornell University. 1944

The authors have presented the basic principles of conservation so that the reader may understand both today's and tomorrow's problems in relation to the broad subject of conservation.

The first section deals with the soil and water resources of the United States. Special emphasis is given to ways of maintaining the productivity of the soil and of controlling loss of soil by wind and water erosion.

The second section tells of forest and associated range resources, together with public parks. It describes the Nation's existing resources, traces the steps by which forest and grazing lands have been depleted, shows the extent to which forest conservation has developed, and presents a constructive program for future action.

The third section deals with wildlife. Attention is called to the great economic value of the fisheries and to the far-reaching recreational significance of game animals. The abundance of wildlife in the past and some of the more significant factors responsible for its decline are reviewed. The authors point out very clearly that wildlife, the esthetic value of which is acknowledged, is a product of the land and should be made available for the enjoyment of everyone.

The fourth section deals with metals, minerals, foods, and nonmetallic minerals. The importance of mineral wealth is stressed and the extent of present nonreserves is shown. From the data which the authors present, it is apparent that supplies of many mineral products are not inexhaustible. Measures are suggested for the conservation of mineral resources.

The authors recognize soil conservation districts as being a distinct forward step in furthering the widespread adoption of recognized methods of soil erosion control and of rational long-term soil utilization. They point out a relationship between the private land owner and the public treasury. The term conservation, as used in the book, applies to the wise use of existing supplies of natural resources, the husbanding of those that remain for the benefit of future generations, the restoration and careful management of renewable resources and the establishment of a workable program that will make the soil serve the people perpetually and well. The authors divide the natural resources of the country into two broad classes—those which are renewable and those which are exhaustible. Those that are renewable are primarily of a biological nature. Soils are placed in the class of exhaustible resources; although their fertility may be restored, soil formation requires ages, and soil that is washed or blown away is gone forever.

The authors acknowledge that the natural wealth has been largely responsible for the building of the nation. However, they note that a new era is at hand, that the day of wasteful use is gone and cannot return. It is not without irony that a war may have been the only means of impressing the public with the importance of natural resources and the need for their conservation. Conservation is an economic and social problem. It is not primarily one of sentiment.

In the total conservation and water problem, the authors adhere to the principle that the utmost should be done to educate the farmer and the general public in the control of soil erosion and the conservation of water. If, after a reasonable period of education, the desired control is not attained, it may be necessary for a government agency to take steps toward this end. The authors state that such an agency should have authority and be entirely beyond political influence. The efforts of such an agency need to be directed toward complete conservation of soil and water so that ample food and clothing for the population may be produced, and flood damage and silting of reservoirs minimized.

—Grover F. Brown.

FISH AND FARMS SUFFER

(*Continued from p. 8*)

The community of interests involved is obvious, but a common concern that leads to united action has not yet evolved. The effort must be directed at the source of the trouble. It is essential that the top soil be kept on the farms throughout the northwest section of Ohio. This will make possible continued good farm production of essential food crops, will make better stream fishing for the sports fishermen, better hunting along the stream bottoms, and better food production in Lake Erie.

Do your part to reduce accidents!
NATIONAL FARM SAFETY WEEK
July 23–30

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[1] From Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

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